D5.302:M32

MC&G

...A Brief History of U.S. Military Mapmaking—and The First Decade of the Defense Mapping Agency

DMA COMPONENTS

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DMA
Aerospace Center
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Fort Belvoir, VA 22060

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MC&G
Mapping . . . Charting . . .
Geodesy

Mapping, Charting, and Geodesy . . . these are the functions of the Defense Mapping Agency, which is charged with providing Mapping, Charting and Geodetic support to the Department of Defense. Throughout this booklet there are many references to M C & G. By simple definition:

MAPS are used for ground operations of all types.

CHARTS are used for air and sea navigation.

GEODESY is the science of determining the size and shape of the Earth, the precise positions of points on the Earth's surface and variations in the pull of gravity—all of which are significant to modern weapons systems.

THE MISSION

of the Defense Mapping Agency

To provide Mapping, Charting and Geodetic (MC&G) support and services to the Secretary of Defense, the Joint Chiefs of Staff, the Military Departments and other DoD components through the production and worldwide distribution of maps, charts, precise positioning data, and digital data for strategic and tactical military operations and weapons systems. Also, to provide management and coordination of all DoD MC&G resources and activities and to carry out statutory responsibilities to provide nautical charts and marine navigational data for the use of all vessels of the United States and of navigators generally.

I am pleased and proud to present
this Brief History of U. S. Military Mapmaking and highlights
from the first decade of the Defense Mapping Agency — the dramatic and transitional period 1972—1982.

For many generations, military ground forces, ships and aircraft routinely included maps and charts among their basic equipment, often adapting them by hand to their immediate needs. For the post-World War II generation this would no longer suffice, as exploding technology tremendously increased both the speed and scope of virtually all military operations. Command and control, navigation and fire control systems became automated through computer technology, demanding vast amounts of information, in seconds.

This same technology spawned a new generation of weapons systems — including short and long range missiles which travel hundreds, even thousands, of miles and require pinpoint accuracy, literally from point to point on the surface of the Earth. It is DMA's task to provide guidance data for these systems, for all the MC&G needs of the Armed Forces. To meet these requirements, the military cartographer's art also was transformed, by sophisticated electronic tools, complex new techniques and increasing demand for maps, charts and geodetic information in digitized form.

The consolidation in 1972 of the mapmaking efforts of all the military services into this joint Agency melded talented and highly competent groups of people, military and civilian, into a single and more effective organization, which has met great challenges in an innovative and professional manner, and earned a reputation as the premier cartographic facility in the western world.

Following is the story of the development of this unique profession
and the progress of the Defense Mapping Agency during a decade of dedication to our nation.

Sincerely,

RICHARD M. WELLS
Major General, USA
Director

July, 1982

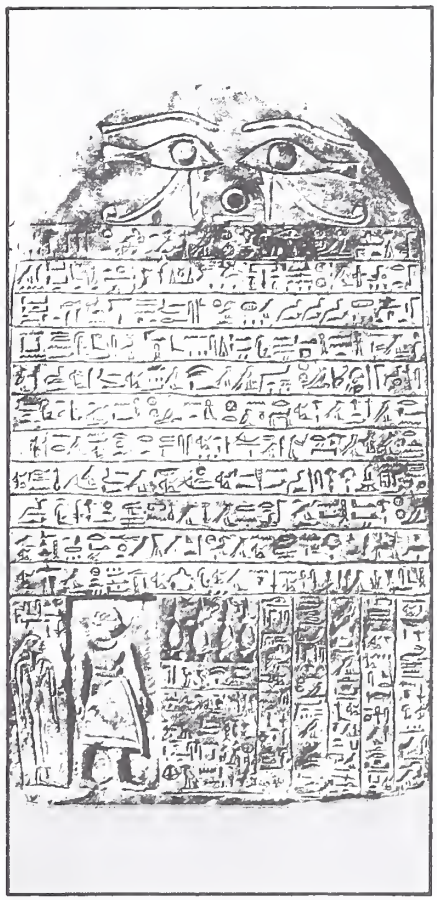
PTOLEMÆUS
ROMÆ 1490.

The art of representing the environment on maps dates back to the earliest recorded times of mankind, from the walls of caves to rolls of papyrus, to the parchment of early civilizations and their explorers, merchants and fighting men.

Among the ancients, Homer in 800 B.C. thought the Earth was flat; Pythagoras two hundred years later was convinced the Earth was spherical. Plato in 300 B.C. guessed its circumference to be about 40,000 miles; Eratosthenes a century later first computed this circumference mathematically and determined it to be 25,000 miles—remarkably close to today's generally-accepted distance of 24,901 miles.

As late as the 16th Century, British and French scientists were engaged in an intense dispute over whether the Earth was flattened top and bottom as Newton's theories had determined, or egg-shaped as the Frenchman, Cassini, maintained. It was 1735 before a pair of expeditions to Peru, near the Equator, and to Lapland, close to the Arctic Circle, brought back measurements to prove that Newton, after all, was correct.

Military mapmaking developed from the time of the Greeks and Persians, through the Romans to the Middle Ages, and into the era of world exploration, then the colonization and conflict of the New World.



(Top)

Early civilizations engraved information on land records and other cartographic data on various types of clay and stone tablets.

Astrolabes, such as this 14th century English model, measured the altitudes of celestial bodies and were used in determining positions on Earth for early ocean navigation and chart making.
(Smithsonian Institution)

Road to Malden
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Winnisimet Ferry
CHARLESTOWN
Hudsons Pt
North Battery
Hancocks Wharf
Long Wharf
BOSTON
South Battery
Little Cove
Powder Horn
Fox Hill
Dorchester
Flats
Brookline
Redoubt
Gun Battery
Fortifying Battery
Roxbury
Boston Neck
Dorchester Neck
Stony Brook
Roxbury Fort
Dorchester Heights
Willis Cr.
Charlestown Neck
Charlestown Common
Bunkers Hill
Breeds Hill
Morton's Pt
Barton Pt
Powder House
Brookline Fort
Redoubts & Out Works
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Fort No. 100

REFERENCES
1 Cambridge, Washington's head-quarters
2 American Centre and reserve
3 Brookline.
4 Roxbury.
5 American right wing, Gen Ward.
6 Dorchester
7 American advance line.
8 Block House.
9 Floating Battery, now about cor Dorer & Washington Sts
10 Nocks Hill, now part of South Boston.
11 Noddles Island, now East Boston.
12 Winnisimet, now Chelsea
13 Charlestown, Bunker & Breeds Hill.
14 American left wing, Gen Lee.
SCALE OF MILES
0 1/2 3/4 1
Gen. Washington's Revolutionary Campaign War Map.
Boston, 1776.
by A.O. Crane, Boston, Mass
HOG ISLAND
Apple Isla
Shirley Point
Pulling Point
DEER
GOVERNOR
ISL
Western Channel
NANTASKET ROAD
LONG ISLAND

AMERICAN MILITARY MAPPING

United States military mapmaking dates from June 1775 with the appointment to command of the Continental Army of General George Washington, who a quarter of a century before had surveyed and mapped much of the Shenandoah Valley in Virginia. Within 48 hours of taking command, Washington had appointed Colonel Richard Gridley to be the nation's Chief Engineer.

The former British Army officer worked his men all night mapping out and constructing fortifications to protect American soldiers in the historic battle of Bunker Hill the next day—the first major effort of an American Corps of Engineers which has remained active to the present day.

In the Spring of 1776, Washington transmitted to Congress one of the earliest maps on record in the federal government (now in the National Archives) with the comment, "... I accordingly have the pleasure to enclose you Colonel Gridley's report of the Harbour and works of New London, with the several plans he has taken, which appears to be accurate and well done ..."

As the relatively localized fighting of the Revolution's early years evolved into larger campaigns in more distant areas, Washington recognized the need for full-time cartographic support and, in July 1777, obtained from Congress a resolution that: "General Washington be empowered to appoint Mr. Robert Erskine ... geographer and surveyor of the roads, to take sketches of the country, the seat of war, and to have responsibility for procuring, governing and paying the guides employed under him ..."

A native of Scotland, Erskine had come to the colonies to manage an iron foundry. To his administrative talents, he added those of engineer, surveyor, inventor and draftsman. Erskine first became known to Washington as a fabricator of link chains and *chevaux de rise*, forged in Erskine's plant as impediments to the British fleet's control of strategic waterways. It is likely that he also had compiled a map or two and some sketches for the American general.

Now, under the first known official authorization by the federal government of a mapping agency, Robert Erskine assumed his new duties on July 27 and began gathering a cadre of surveyors and draftsmen. From their work more than 130 "items" containing over 250 maps and portions of maps pertaining to the Continental Armies' movements and battles were compiled.

It is not clear whether Erskine's preference or circumstances decreed it, but this original unit set a precedent for military mapping units in the United States with a mix of both civilians and military men—a pattern which continues today.

(Right)
George Washington, shown surveying the site of Washington, D.C., had a life-long interest in mapmaking and appointed the first military cartographic unit early in the Revolutionary War. (Source: Library of Congress)

(Opposite)
John Ward Dunsmore's painting, "Washington Studying the Plans of Battle," illustrates the integral part mapmakers have played in all American campaigns. (Source: Fraunces Tavern Museum, New York City)

4 Erskine did not live to see the fulfillment of his concept of a permanent military cartographic agency, but died in the fall of 1780. In one of history's ironic displays, at almost the hour of his death and only a few miles away, British Major John Andre was executed as a spy—after being apprehended with maps in his possession detailing the disposition of the American forces.

Erskine's principal assistant, Simeon DeWitt, succeeded him, and was later joined by Thomas Hutchins, a British officer with cartographic skills who, in 1781, became cartographer-surveyor to the Continental's Southern Army.

At war's end, the "Survey Department" of the Continental Army was demobilized, as the entire Army was reduced to 80 men. Hutchins, however, was named first Geographer of the United States and played a leading role in the establishment of the first peacetime mapping agency of the federal government, the General Land Office (now the Bureau of Land Management).

The next few decades saw considerable effort directed towards surveying the boundaries of the states and the lands in the new West, including the area of the Louisiana Purchase of 1803.

A resurgence of military mapmaking came with the appointment of members of the Army's Topographical Engineers—mostly from the line of the Army—during the War of 1812. Post-war demobilization again reduced this to a cadre of only two officers in 1815. However, the next few years saw their number increase and, in 1818, Secretary of War John C. Calhoun reorganized the War Department and added a centralized Topographical Unit.

Congress established the Topographical Engineers as a separate Corps in 1838 and named Colonel John J. Abert, who was then chief of the Topographical Bureau, as its commander. Colonel Abert guided the Corps of Topographical Engineers throughout its quarter of a century of existence, and it was under his leadership that much of the dramatic exploration and mapping of the West was conducted.

Military mapmakers led the way across the plains and the Great Divide to the Pacific, later mapping the rivers and routing new highways and canals, then railroads. Always leading the surge of settlers behind them were such explorers as Captain Meriwether Lewis and Lieutenant William Clark, who need no introduction to any American schoolchild; Major Stephen H. Long, who crossed the Rockies in 1819–20; and Lieutenant John C. Fremont, known as "The Pathfinder," who mapped the Great Northwest.

6

This map, drawn for the U.S. Senate in 1848, was taken from surveys by Fremont, who trekked over the wild western territory more extensively than any white man before him. (Drawn by Charles Preuss; Litho by E. Weber & Co., Baltimore)

Navy's First Chart Depot

Meanwhile, in 1830 in the new capital city of Washington, D.C., a young officer, Lieutenant L. M. Goldsborough, was setting up the Navy's newly-authorized Depot of Charts and Instruments in a rented house on downtown G Street—simply a warehouse where navigational information and instruments were stored and issued to various ships.

Five years later, Lieutenant Charles Wilkes installed a lithograph press and, in 1837, the first four engraved nautical charts were issued by the Depot—of Georges Shoal and Bank, a fishing ground off Cape Cod in the Atlantic. The charts were developed from surveys conducted by Lieutenant Wilkes.

An interest in the development of astronomical science by Lieutenant James S. Gilliss, who had succeeded Lieutenant Wilkes in charge of the Depot, led to authority to enlarge its functions to include an astronomical observatory. In 1842, Congress appropriated funds for a permanent site for the "U.S. Naval Observatory and Hydrographic Office" on land that George Washington had originally proposed as the site of a national university, near the present State Department. Thus began the function, still critical to navigation on the seas—as well as on land and in the air—of precise positioning of celestial bodies which marks a principal responsibility of the Naval Observatory today. The Navy separated the Hydrographic Office from the Observatory in 1866.

Most renowned director of the Navy's Depot was Lieutenant Matthew Fontaine Maury, often described as the "Founder of Oceanographic Science."

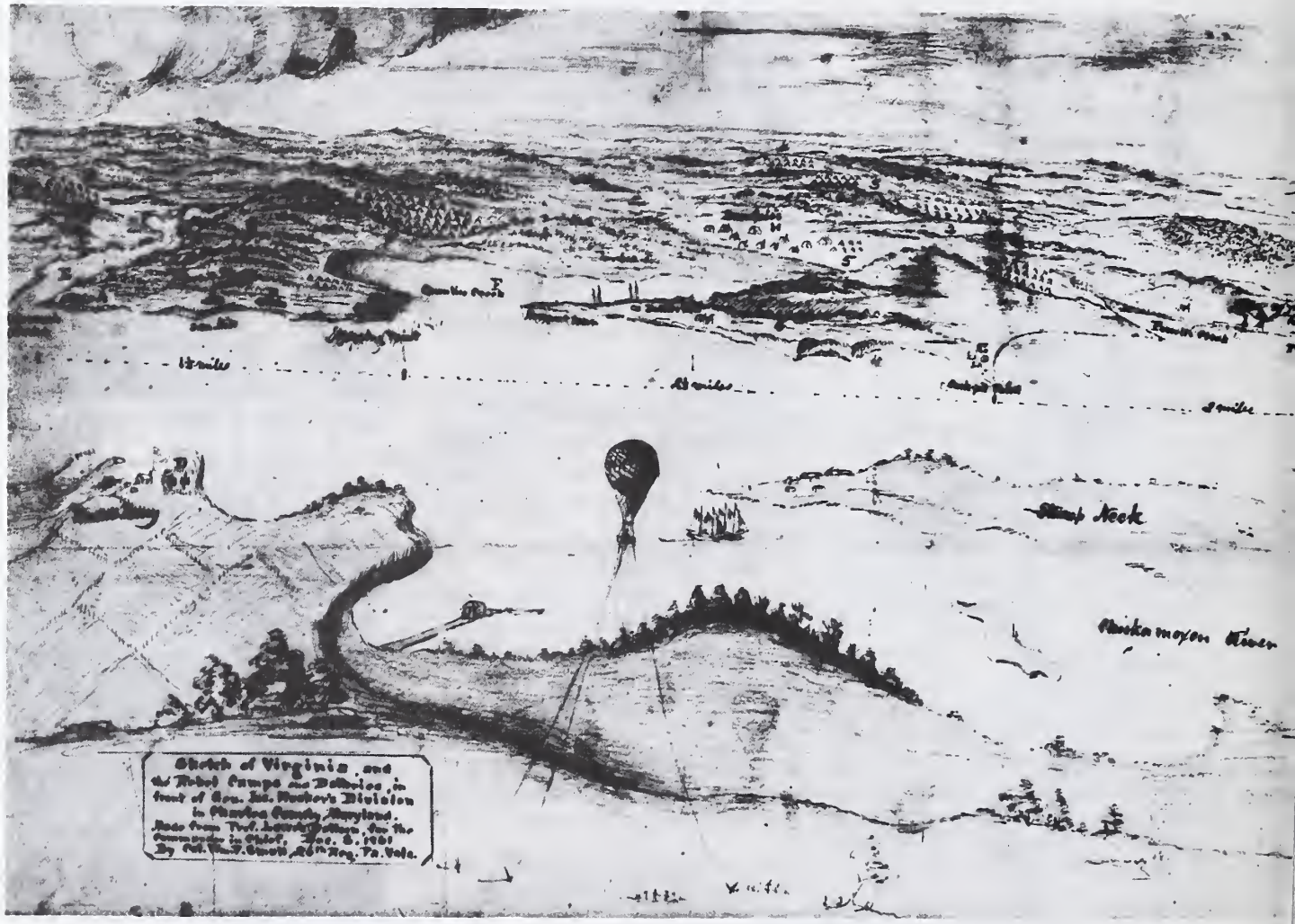
Particularly concerned with the sparsity of knowledge of winds, currents and general weather conditions along ocean shipping routes, Lieutenant Maury stimulated sea captains to report their experiences on the world's trade routes, so that the data could be compiled and published for the benefit of all.

In 1847, the first "Wind and Current Chart of the North Atlantic" was published, based upon these reports—the predecessor of today's detailed Pilot Charts. By 1859, Maury's charts had reduced sailing time from the East Coast to California from 183 to 135 days and a round trip from England to Australia took 160 rather than 240 days.

The work of exploring, mapping and charting, on land and sea,

Lieutenant Louis M. Goldsborough

Lieutenant Matthew Fontaine Maury



expanded during the tragic days of America's Civil War, with topographic and hydrographic officers serving in both armies and both navies. During the Civil War manned balloons were used for the first time to observe and record the disposition of enemy forces—to do the first aerial mapping in this country, foreshadowing the aerial photography that has become indispensable in mapping and charting the world as we know it today.

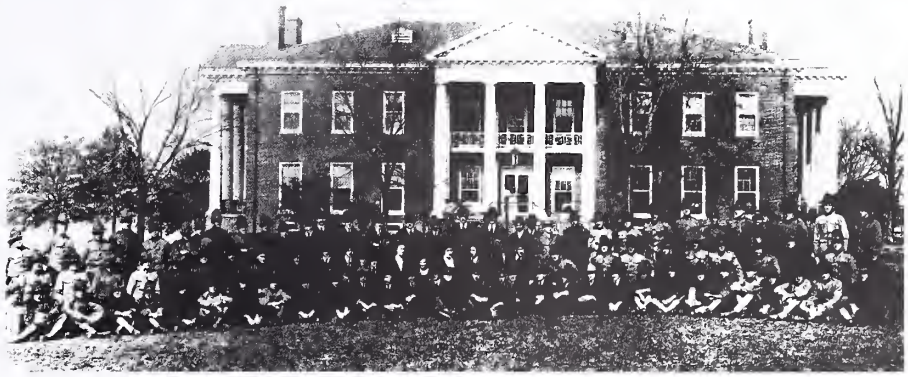
This legend reads: "Sketch of Virginia and the Rebel Camps and Batteries in front of Gen. Joe Hooker's Division in Charles County, Maryland. Made from Prof. Lowe's Balloon for the Commander in Chief, Dec. 8, 1861, By Col. Wm. F. Small, 26th Reg. Pa. Vols."

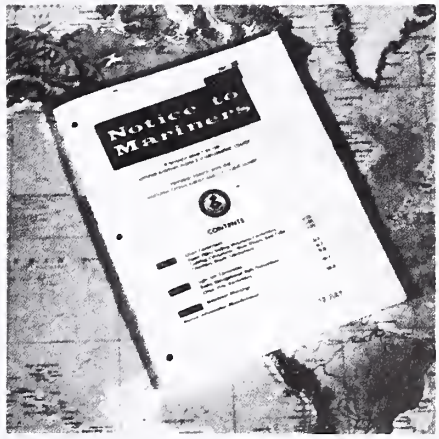
Post Bellum Growth

After the Civil War, with the westward movement growing, Army surveyors resumed exploring and mapping. These early efforts led to preservation of the areas which became Yellowstone, Yosemite and Sequoia National Parks. National civil projects included mapping out improvements to America's water resources, rivers and harbors.

In 1869, the Navy Hydrographic Office inititated its renowned "Notice to Mariners", which passes changes in nautical charts to thousands of Navy and Merchant Marine vessels around the world, including such navigational information as new channel markers, wrecked ships, newly-discovered shoal areas, etc. Traditionally a weekly mail service, this system has recently been automated so ships at sea may contact Washington directly via satellite and obtain the latest chart information computer-to-computer.

In 1871, the process of photolithography was introduced in the Hydrographic Office, much improving its charts. In 1889, a proposal from the Hydrographic Office recommended a standardized system of names for geographic and maritime features. The result was the U.S. Board on Geographic Names, which still functions today to establish standards and eliminate confusion in designating place names around the world for official U.S. purpose.





(Top)

Soldiers and civilians lined up in 1918 for a formal photograph in front of the Engineer Reproduction Plant at the Washington Barracks, now Fort Leslie J. McNair, in Washington, D.C.

(Above)

For more than a century, Navy and Merchant Marine charts have been updated through the Notice to Mariners. It is now computerized and supplemented by a daily radio service as well.

In 1909, the Army's Central Map Reproduction Plant was established in an Engineer Corps warehouse at Washington Barracks (now Fort Leslie J. McNair) in the District of Columbia. Later, in 1917, it was combined with a photographic laboratory and the Engineer School printing facility into the very active Engineer Reproduction Plant. This reorganization, conducted by Captain Charles H. Ruth, was in anticipation of map supply needs in World War I. During that conflict, the Engineer Reproduction Plant produced some nine million maps.

Defense Mapping School Founded

The first lithographic school in the Army was established as part of the Map Reproduction Plant in 1910 and in the spring of 1918 a military School of Surveying, Map Reproduction and Ranging was established at Camp A. A. Humphreys (now Fort Belvoir, Va.) to train mapmakers during World War I. Later, this school became the Department of Topography of the U.S. Army Engineer School at Fort Belvoir. Prior to its incorporation into the Defense Mapping Agency as the Defense Mapping School, "D/TOPO" had trained Army topographers for three more wars and had become a leader in interservice training. Today, the Defense Mapping School has a joint service staff and trains personnel from all services as well as selected civilians and Allied officers.

Following the sinking of the Titanic, which collided with an iceberg in 1912, the Hydrographic Office was instrumental in establishing the International Ice Patrol, begun by two American destroyers and still operating today.

While information required to maintain and update charts had been relayed by telegraph as early as 1874, it was in 1920 that the Hydrographic Office established a radio service with ships at sea to report and relay information on ocean conditions, changes, or misplaced markers as an aid to mariners. This 24-hour service continues today, and includes warnings of wars and political crises as well, usually at the request of the State Department.

The Hydrographic Office staff produced the first United States aviation charts in 1918 for use by World War I fliers. In 1922, sonic sounding devices were perfected to a practical point and the Navy fitted two destroyers with these electronic depth-measuring devices and obtained a complete profile of the Atlantic and Mediterranean along the course traveled by the two ships—first steps in development of the multitude of electronic devices used today to collect data.

Also in 1922, aerial photography was first employed by the Hydrographic

An aerial camera replaced machine guns in this World War I open airplane, and called for interesting flying to obtain its photographs. Such pilots as this one, pictured in 1919, pioneered a technique which revolutionized mapmaking.

(Top)

Amphibian planes such as this one were used in early surveys by the U.S. Navy.

(Bottom)

Critical to all phases of World War II campaigns were operational briefings, such as this one given to allied officers in a North African command post.

(Center)

These cartographers at the Engineer Reproduction Center at Fort McNair in the late 1930s worked in conditions far removed from the computerized (and airconditioned) production centers of today's Defense Mapping Agency.

Office in surveys conducted off the coast of Cuba. Today, this science of photogrammetry permits precision mapping from aerial photographs. By 1925, Hydro had developed an aerial navigation section.

The Army Air Corps, in December 1928, established a Map Unit under its Information Division in the Munitions Building in Washington, D.C. The Information Division's name was changed to the Intelligence Division in January 1941, and the Map Unit remained part of it, with a strength of 20 officers and civilians.

The Geographic Section of the War Department General Staff, which kept custody of the General Staff Map Collection, was transferred to the Army Corps of Engineers, effective in April 1939.

World War II Expansion

When World War II burst upon the nation, these relatively small Army, Navy and Air Corps units had to meet a demand for extreme and rapid expansion to provide the worldwide requirements of that conflict.

The Army's Geographic Section and Engineer Reproduction Plant moved from the Army War College to nearby Brookmont, Md., in 1942 and became the Army Map Service (AMS). Its 150-member staff of military and civilian professionals eventually expanded to more than 3,500.

During World War II, the AMS produced more than 500 million copies of more than 40,000 different maps—covering some 400,000 square miles. More than 70 million copies of 3,000 different maps were required for the Normandy Invasion alone.

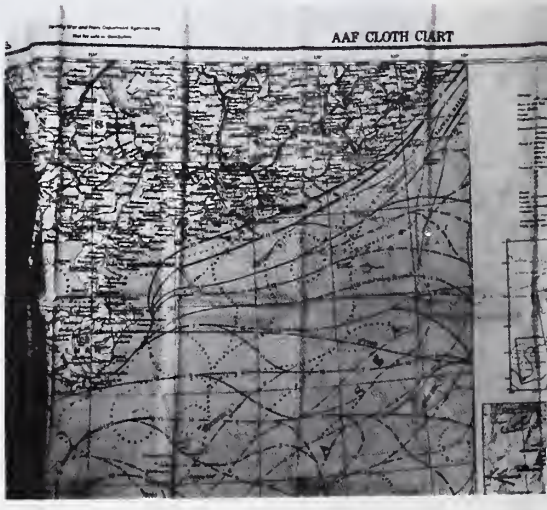
Following the attack on Pearl Harbor, requests for Navy charts increased to more than 40 times the normal demand. In 1942, the Hydrographic Office occupied a new office building and plant in Suitland, Md., also a Washington suburb. At the peak of the conflict, the Hydrographic Office was producing charts at the rate of more than 43 million copies per year, with significant production coming from three survey ships which contained presses and other equipment necessary to produce navigational products at sea.

Aerospace Charting Begins

In early 1942, the Army Air Corps transferred its Map Unit to the Office of the Chief of the Army Air Forces at Bolling Field, D.C., and by March of that year its strength had increased to 42 officers and 142 civilians. In 1943, an Aeronautical Chart Division was designated and an Army Air Force Aeronautical Chart Plant was established at the Midwest Terminal Building in St. Louis. These became the Army Air Force Aeronautical Chart Service in April of 1944.

World War II Army Air Corps pilots make a last minute check of aerial charts prior to take-off on a bombing mission.

(Right)
Folding cloth charts, such as this one of the China Sea area, were carried in pockets of World War II airmen.



IAGS Founded

In the mid-1940s, the Pan American Institute of Geography and History (PAIGH) asked the United States government to establish an agency to coordinate, promote and encourage cartographic studies in the Latin American nations, to improve defense posture in that area. President Harry Truman directed the War Department to establish long-range mapping projects in the Caribbean and in Central and South America. To fulfill this responsibility, the Inter American Geodetic Survey (IAGS) was founded in 1946, headquartered in the Panama Canal Zone under the Army Corps of Engineers. During the intervening 36 years, IAGS has coordinated and encouraged cartographic studies and related projects throughout Latin America, significantly advancing the status of mapping, charting and geodesy there, with a concomitant benefit to hemispheric defense. Since 1952, more than 5,000 individuals have graduated from the IAGS Cartographic School at Fort Clayton, Panama, after training that ranges from basic cartography to advanced technological courses in satellite positioning and automated cartography.

During the Cold War that followed the struggle against the Axis, military mapmaking facilities continued to meet heavy demands for products necessary to prepare for renewed hostilities in any part of the globe. A return to wartime status came quickly, with the outbreak of hostilities in Korea, and millions of maps and charts were produced to meet the requirements of the Armed Forces there.

All three services shifted their MC&G units among various commands during the next decade and a half, in most cases assigning greater responsibilities and higher levels of command.

The Army Air Force Aeronautical Chart Service went to the Air Transport Command in 1946, to the Strategic Air Command in 1947, to the Air Material Command in 1950 and, in 1952, as the Aeronautical Chart and Information Center, was assigned to the Military Air Transport Service and based in St. Louis. In the late 1950s and early 1960s, ACIC made a radical move to convert its journeymen from cartographic aides to physical scientists/geodesists, thereby making possible support of Intercontinental Ballistic Missiles, the World Geodetic System and development of basic technology to support the advanced systems of the 1980s. In 1960, ACIC was designated a separate operating agency under Headquarters, U.S. Air Force, with procedural functions and responsibilities of a major air command.

Shooting for the Moon

During the 1960s a major—and unprecedented—effort at ACIC and AMS was development of special mapping and charting materials for America's early space effort. Begun in 1959, this program was directed simultaneously at providing operational charts for the manned space capsules and at development

Using Lunar Orbiter and Apollo photography, a lunar mosaic is prepared at ACIC, part of the mapping of the Moon required by U.S. astronauts.

of detailed maps of the moon, preparatory to a manned landing there.

From the one-man Project Mercury space shots through the first lunar landing of Apollo 11 in 1969, ACIC worked closely with NASA and with the astronauts individually to produce more than 30 items for their use and for the guidance and recovery teams.

Another ACIC team, meanwhile, began a long relationship with personnel at the Navy's Lowell Observatory Telescope at Flagstaff, Arizona, using the powerful equipment at that facility to gather data used in their initial maps of the moon's surface—the first new lunar mapping since that done in 1874 by

(Left, above)
Huge models of the Moon's surface were constructed prior to the lunar landing missions and used in simulator training for the astronauts.

(Left)
Moon landing sites and alternatives were selected well in advance of the missions.

German astronomer Julius Schmidt. From the first crash landing on the moon of Ranger VII came more than 4,000 photographs—the first significant amount of lunar image data collected from outside the Earth's atmosphere.

Later, the unmanned Lunar Orbitor and manned Apollo missions acquired data and photographs which enabled ACIC and AMS to provide maps to support the landing of astronauts on the moon. These organizations also used this data to remap the moon for NASA, including publication of the first maps of the lunar farside.

In 1946, the Secretary of the Navy designated the Hydrographic Office as the central agency for all basic research pertaining to hydrography and, in 1962, the Hydrographic Office was renamed the U.S. Naval Oceanographic Office to reflect growing emphasis on all aspects of the ocean environment.

It was in 1968 when Army mapping reached a new plateau with establishment of the Army Topographic Command, incorporating all the MC&G assets of the Army Map Service, the Army Engineer Topographic Laboratories, two historic Engineer Topographic Base Battalions and selected staff elements of the Engineer Corps. At the same time, a new Topographer of the Army was appointed and joined the staff of the Chief of Engineers.

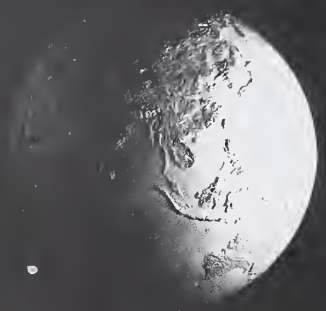
Time of Change

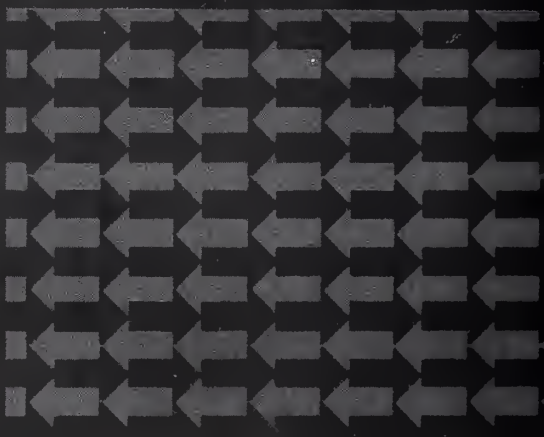
Meanwhile in the 1950s, the Office of the Secretary of Defense had become concerned that the three services might be duplicating the ever more exotic MC&G equipment and systems then under development. At about the same time, a decision was made to establish the Defense Intelligence Agency to consolidate major national intelligence efforts. Because a large part of the various mapmaking programs was under the supervision of intelligence components of the services, it seemed logical then that management of military MC&G programs be assigned to the proposed Defense Intelligence Agency. When DIA was established in 1962, it included a Mapping and Charting Directorate with a staff of 90.

During the next decade, this DIA Directorate made significant progress in determining MC&G requirements, establishing program guidance, developing priorities, integrating programs and eliminating some duplication between the services.

However, management problems arose because, while the Directorate was responsible for program management, management of actual MC&G resources remained within the military services. DoD organizational studies began to indicate that MC&G activities should be separated from intelligence community activities.

In 1970, the President's Blue Ribbon Study Committee recommended consolidation of all MC&G activities into a new centralized agency. In the fall of 1971, President Nixon directed a reorganization of the Defense Department's intelligence effort and the establishment of a new Defense Mapping Agency.





THE DEFENSE MAPPING AGENCY ESTABLISHED

THE DEFENSE MAPPING AGENCY ESTABLISHED

DMA was officially established in January 1972 and became operational July 1st of that year as a separate defense agency, reporting to the Secretary of Defense through the Joint Chiefs of Staff.

Lieutenant General Howard W. Penney of the Army Corps of Engineers was selected as first director of the new Defense Mapping Agency. In February 1972, supported by a staff temporarily assigned from various DoD components, he began the complex task of determining which mapping, charting and geodetic functions and which personnel of the military services should best be incorporated into this new joint agency and which should remain within the Army, Navy or Air Force—all in line with the President's requirement for efficiency and economy without impairing the many legitimate requirements of the military departments.

The approach selected was to include in DMA the major MC&G production facilities and to retain in the military services those functions concerned with the acquisition of basic data for map and chart development as well as most research and development.

Lt. Gen. Howard W. Penney

Thomas C. Finnie

As it developed, the new Defense Mapping Agency absorbed about 80 percent of the MC&G capabilities of the various services, which had involved nearly 12,000 individuals and budgets totalling some $200 million.

In addition to the MC&G Directorate of the DIA, the new mapping agency incorporated under its command structure: portions of the MC&G staffs of the military departments, production activities of the Army Topographic Command, the hydrographic charting portion of the Naval Oceanographic Office, the Aeronautical Chart and Information Center of the Air Force, the 1381st Geodetic Survey Squardon of the Military Airlift Command and the MC&G portion of the Strategic Air Command's 15th Reconnaissance Technical Squadron, the Inter American Geodetic Survey and the Department of Topography of the Army Engineer School.

In addition to branch offices of the IAGS in Central and South America, the new Agency inherited scattered units in 14 states and half a dozen foreign nations.

The new DMA staff also inherited three separate and well established traditions, methods of operation and administrative philosophies—one from each service—plus that residual resentment towards change and, particularly, amalgamation that any new, unified agency must face.

DMA Components on preceeding divider pages:
1. Headquarters, 2. Defense Mapping School, 3. Aerospace Center, 4. Office of Distribution Services, 5. Inter-American Geodetic Survey, 6. Hydrographic/Topographic Center

At the same time, the new administration faced the critical requirement of ensuring that ongoing mapping and charting activities of the Defense Department should continue uninterrupted, that vital information used in all phases of military operations would be compatible and accurate and available when needed.

An early decision was made to establish the smallest possible headquarters to provide policy, program guidance and review, while operating authority was decentralized to subordinate components to the maximum extent possible. DMA Headquarters was established with a roster of 190 people, about one-fourth military personnel, the remainder civilians. Overall, DMA personnel included about 1,000 military personnel and nearly 8,000 civilians, all specialists in their professions.

The initial directives left virtually all production personnel in place and continued ongoing programs, pending detailed review of possible realignment of functions in the interests of economy, efficiency and responsiveness.

At the same time, General Penney established the DMA Effectiveness/ Productivity (E/P) Program, with an initial goal of increasing productivity by 10 percent in the first three years of combined effort at DMA. The goal was not only met, but exceeded, and the DMA E/P Program was highlighted in a Presidental Report to Congress.

Perhaps most illustrative of the future operations of this blend of three services—and the mixture of highly skilled military personnel with experienced civilian professionals in the various complex disciplines of mapmaking—was inclusion in the original chain of command of a civilian Deputy Director, Management and Technology, the senior civilian of the Agency.

Thomas C. Finnie, who first held that post, and General Penney developed a rapport and an administrative concept that have continued during the Agency's existence, modified as dictated by circumstances and the individuals involved, but consistently so efficient that DMA has suceeded in meeting both the demands of an exploding technology and the requirements of burgeoning weapons systems.

On these two points, actually, were many of the early concerns of the military services based. Would this new, combined agency be able to meet the unique requirements of military ships and planes, and soldiers and Marines in the field? On time? And in a future of missiles and satellites, of virtually computerized warfare.

(Top)

The Image Manipulation System checks digital data stored on tape against an original, printed map or chart.

(Center)

This precision point transfer device is used to relate a series of aerial photographs to one another and to known points on the Earth.

(Bottom)

A wide variety of computers is used by DMA in developing digital data output for navigation and weapons system guidance and, to a growing degree, in production of traditional paper and charts.

Into the Computer Era

Along with the reorganization of those early years, which was directed towards eliminating duplication of effort and insuring the best use of facilities, came the decision to increase responsiveness to the new, electronic technology which was to revolutionize the MC&G profession.

Perhaps this all began when the Army Map Service became one of the first governmental agencies to utilize a large-scale computer—acquiring the third production model of UNIVAC I ever built. In the intervening years, DMA has led the way in the transition from those vacuum tube computers, through the transitor era, into the micro-miniaturized equipment of today.

At about the same time, military photogrammetrists, working with aerial photographs, harnessed emerging technology to develop the first generation of digital topographical data, using stereo photography to calculate terrain factors so contour lines showing the Earth's elevations could be generated more rapidly and economically.

This was the beginning of a highly sophisticated process for the collection of terrain elevation data. Originally intended to speed

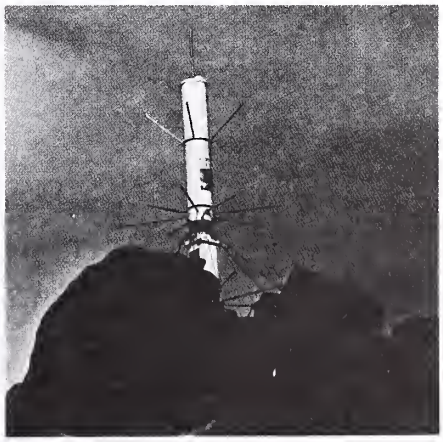
production of traditional paper maps, this digital data markedly improved the production of conventional maps for human beings to read and suddenly became the key to such modern weapons systems as the cruise missile, which carries its own computer.

During this explosive period, Navy Vice Admiral Shannon D. Cramer, Jr., took over the helm of DMA, with Charles H. Andregg assuming the senior civilian post as Deputy Director, Management and Technology. Facing increasing Congressional pressures to cut the Defense Department budget, these officials led a successful effort to ensure an MC&G readiness capability for the nation's Armed Forces. The Agency budget, then at $250 million annually, reflected productivity increased by 10 percent during Admiral Cramer's three-year term (1974-77), savings of more than $43 million and a reduction in personnel of 350 slots.

In these years, DMA made important advances in the vital field of point positioning—that is, determining the location and relationships of different points on the Earth's surface. In addition to the Doppler system, by which signals from orbiting satellites are used to locate a precise point on the Earth, a new technique, known as inertial positioning, was developed to determine the positions and elevations of points relative to one another. Mounted in land vehicles or helicopters, a device known as an Inertial Positioning System (IPS), has been operated by DMA since 1975 and is generating unprecedented relative positioning accuracies—vital to advanced weapons systems such as the MX missile.

DMA initiated a worldwide program to inform the combat commands of the availability through DMA of the new Point Positioning Data Base concept, dramatically improving targeting accuracy in several weapons systems under combat conditions.

Also during this period, the IAGS program was significantly strengthened, returning financial benefits to the United States in excess of $20 million annually, to producing a positive impact on political and diplomatic relationships which cannot be measured.



An early application of satellite technology utilized the Doppler technique to register signals from space through receivers such as this to locate points accurately on the Earth's surface.

Vice Adm. Shannon D. Cramer, Jr.

Charles H. Andregg

Lt. Gen. Abner B. Martin

William T. Riordan

The period 1977-79, under the leadership of Air Force Lieutenant General Abner B. Martin, was a time of consolidation of DMA production and distribution for increased efficiency, of new initiatives in international and inter-agency cooperation and continued advances in highly complex technology.

With William T. Riordan serving as Deputy Director, Management and Technology in 1978, more than 8,300 employees worldwide with an annual budget of some $270 million worked to increase quality control and reduce backlogs of products—and to move ahead in many directions.

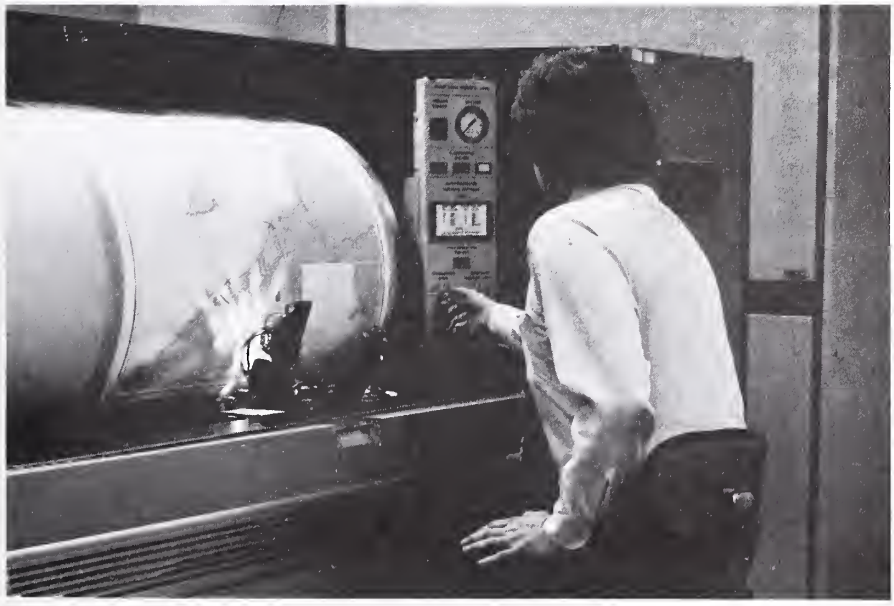
A "shot microscope" is used here to measure widths of lines and symbols to ensure constant representation on maps and charts.

(Right)

New aerial photos are matched via this zoom transfer scope to existing maps and charts to permit updating with the latest cartographic data.

Hydrographic/Topographic Center Formed

A major realignment of DMA component units took place in 1978, when the Agency's Hydrographic Center was moved from its site in Suitland and combined with the Topographic Center in Brookmont. This move, while retaining the visibility of hydrographic and topographic programs, resulted in improved responsiveness to the armed services, increased production effectiveness, and lowered production costs—for an initial savings of $14 million and subsequent annual savings of about $5 million. Inherent in the Hydrographic/Topographic Center as well is a greater flexibility to respond to changes in requirements, priorities and technology, because of the ability to balance production between hydrographic and topographic programs and to utilize common data bases and unified technology.



Office of Distribution Services Established

During the same period, a new component, the Office of Distribution Services (ODS), was established. Through ODS and its network of 13 DMA Geographically Separated Units (GSUs) located around the world, DMA's millions of MC&G products are distributed to the military services, other DoD components, Federal civil agencies, mariners and foreign governments as authorized. Under a U.S. statute, ODS is responsible for the sale of DMA charts and publications to the private sector and civil users in the maritime community. These products are provided by some 225 DMA sales agents around the world. (Digital products are distributed through the DMA Aerospace Center.)

(Top)

Originally designed for the textile industry, the Sci-Tex is used by DMA to scan printed maps and charts, correct and modify them, and then produce color separated negatives for the printing process.

(Center

A coordinate plotting table is used with the analytical plotter to intensify detail developed by scanning stereo models of aerial photographs.

(Bottom)

Laser scanners transfer detail from maps and charts electronically into digital form for traditional printing or into DMA data banks.

In the face of ever more sophisticated guidance techiques in new weapons systems, the military services became convinced of the need for earlier involvement of the Defense Mapping Agency. As a joint service agency, DMA assumed a direct and more essential role in the initial research and planning for these strategic and tactical weapons, missiles and aircraft.

Closer working relationships with the various civilian mapping agencies of the United States were initiated by DMA during this period. In addition to periodic technical exchange programs, DMA today has formal agreements with the U.S. Geological Survey and the National Ocean Survey for cooperation in research and development. Also, the three agencies enter the 1980s in agreement to purchase standarized production systems unless serious operating problems make a specific system impractical for any of them. Agreement has also been reached to work toward standardization of data file formats to simplify cross-utilization of these files and ensure rapid response in emergencies.

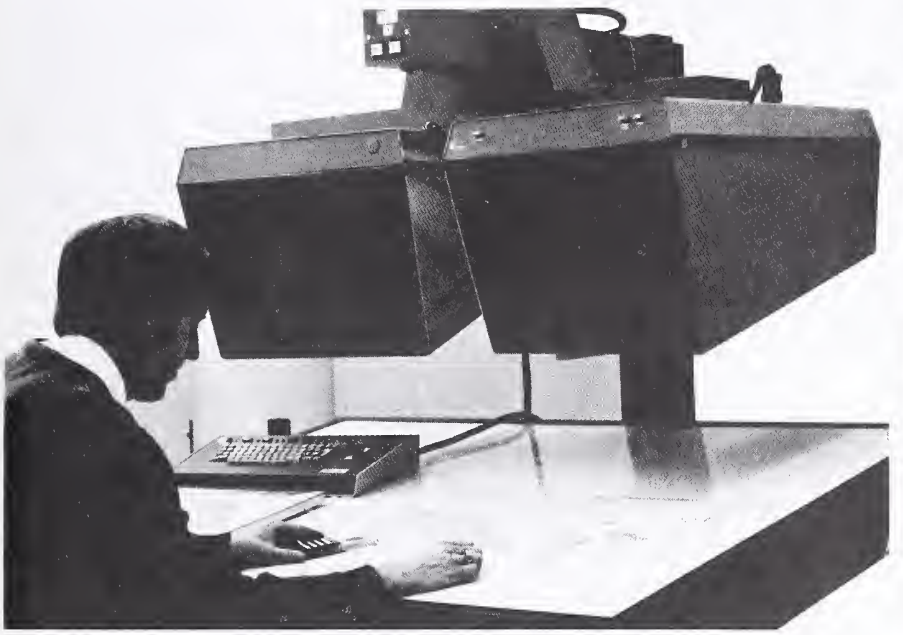
Even in the era of computerized guidance, it's [illegible] goes in an [illegible] millions of copies of [illegible] and charts annually which are distributed to U.S. Armed Forces worldwide.

Accord was reached with the Defense Intelligence Agency to transfer the terrain analysis program from intelligence to the MC&G community, thereby assisting field commanders in exploiting terrain for tactical advantages. With the addition of terrain analysis, DMA was now able to address the full spectrum of topography.

New initiatives were undertaken with the international MC&G communities as well, including close relationships with NATO Allies, insuring acceptance of cooperative programs to collect and exchange digital data, to review mapping and charting specifications in response to changing tactical doctrine and new families of weapons systems, and to develop and use a unified World Geodetic System.

DMA's role in research and development was expanded, and significant advances kept the Agency at the forefront of some of the most radical changes in application of state-of-the-art technology in digital data processing, photogrammetry, cartography, geodesy and photography—perhaps the most radical changes in the history of the profession.

This period also saw a revitalization of DMA's crisis support procedures and establishment of formal crisis response structures within the Agency. Rapid response requirements were fulfilled in support of actual or planned operations in Afghanistan, Iran, Guyana, Zaire, Yemen and others.



A keyboard gives instructions to the AGDS laser scanner in the background, which puts map and chart data into digital form.

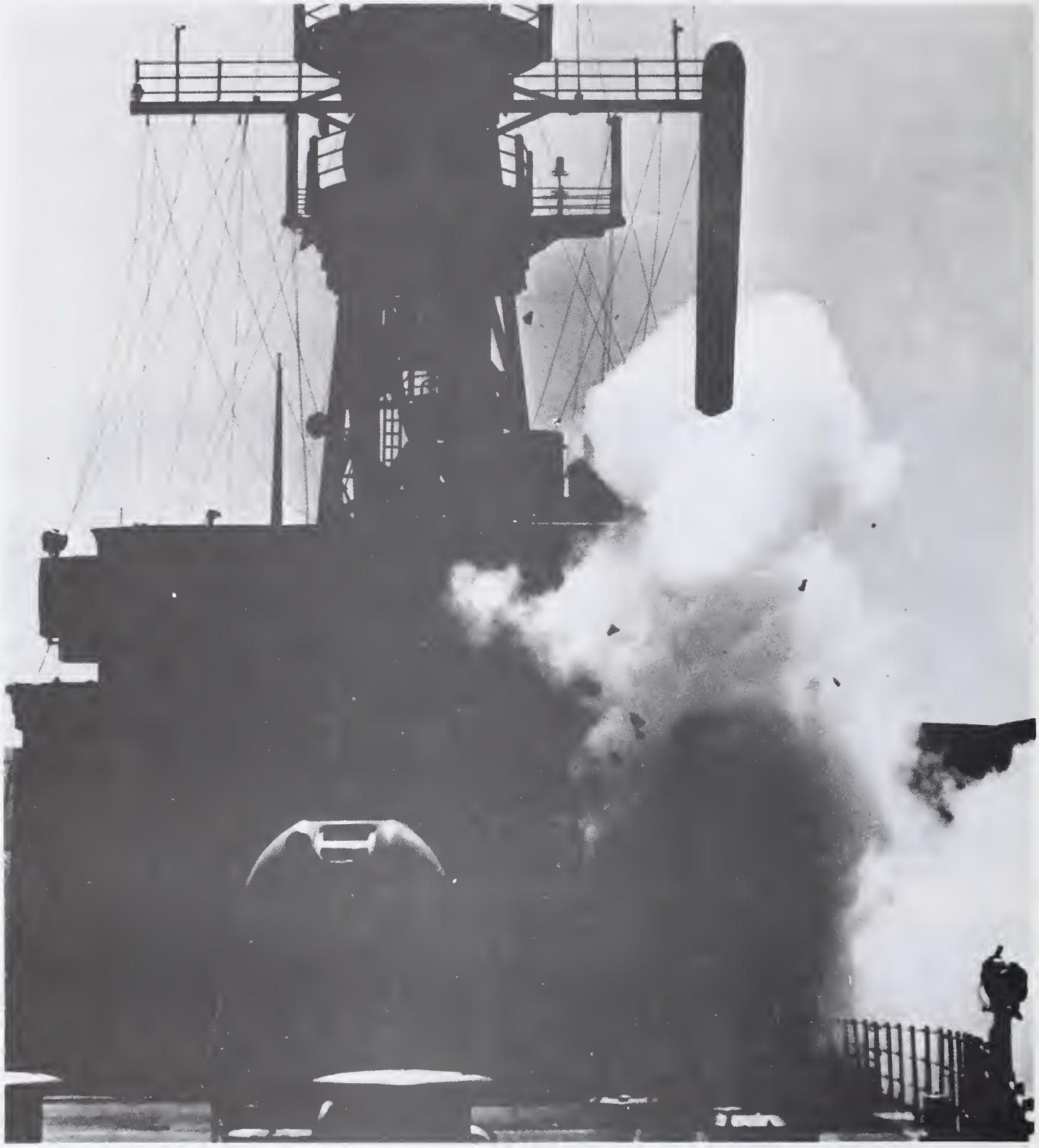
The Defense Mapping Agency moved into an era of significantly increased coordination with the Unified and Specified Commands of the Armed Forces during the tenure of Major General William L. Nicholson, III, (June 1979—July 1981). Through participation in the command post exercise program of the Joint Chiefs of Staff, DMA developed an improved level of inter-service coordination and a substantial increase in the Agency's effectiveness in responding to real-world MC&G requirements.

Working closely with new Deputy Director, Management and Technology, Owen W. Williams, General Nicholson led an agency with more than 8,500 military and civilian personnel and an annual budget in excess of $350 million.

Maj. Gen. William L. Nicholson, III

Owen W. Williams

(Top)
This editing station of the Automated Graphic Digitizing System (AGDS) corrects any errors made by electronic scanners which translate information from standard maps and charts into digitized form on magnetic tapes.



DMA became actively involved in developing priorities and planning for the Cruise Missile, now a weapons system of the highest national priority. Three basic types of digital data for the Cruise Missile were developed.

The first two of these, Digital Terrain Elevation Data and Vertical Obstruction Data, are being used for missile penetration planning. The third type, Terrain Contour Matching Data, is more detailed and used for missile guidance in the final minutes of the flight. Close coordination with all three military services has been vital to planning for operations of the Cruise Missile, which may be launched from land, sea or air.

(Above)

The Cruise Missile may be fired from a warship, as here, from an aircraft or from a ground launcher. DMA data is used in guidance for all versions of this new system.

DMA also marshaled resources to perform site selection and validation surveys for the MX Missile, with over 7,000 gravity points established in the western portion of the U.S., along with other planning necessary for deployment of this vital new program.

The Defense Mapping Agency was in the vanguard of support for the newly-formed Rapid Deployment Joint Task Force (RDJTF), earmarking resources immediately after creation of the new force, and keeping abreast of mission requirements, particularly in the Persian Gulf area and Southwest Asia in general. To provide the multiple mapping products required by the RDJTF, new equipment and additional personnel were needed, and acquired.

DMA was called upon for extensive MC&G support during the Iranian hostage crisis and produced a variety of products specifically tailored to requirements of that situation. DMA and its entire crisis task force received Presidential citations for outstanding work during this episode.

During this time, DMA expanded its continuing program of utilizing agreements with foreign nations to provide the United States with vital source information needed to produce MC&G products at minimum cost. Today, DMA has exchange and cooperative arrangements with over 200 organizations in some 80 nations.

In 1980, IAGS Headquarters relocated from Panama to San Antonio, Texas, in an orderly transition and internal reorganization. DMA officials further enhanced the image of the Inter American Geodetic Survey component through personal contacts with top level officials of the host countries and leaders of U.S. agencies at many locations. IAGS now has close working relationships with 20 Latin American nations.

The Defense Mapping School also moved ahead during this period. It was reaccredited by the Southern Association of Colleges and Schools with "zero defects" and with a self-study report which is now being used as a model by the SACS. A steady stream of soldiers, sailors, airmen and marines, as well as selected civilians and foreign nationals, passed through the school, filling billets throughout the services with vital specialists.

July 1981 marked resumption of command of DMA by an Army Corps of Engineers officer when Major General Richard M. Wells became Director of the Agency.

A high order Theodolite such as this produces top quality ground surveys, still vital to accurate mapping.

General Wells assumed his post as the new Administration in Washington initiated a program of rapid expansion of the nation's military capabilities—a decision that had significant impact upon the Defense Mapping Agency.

The resultant expansion of the country's strategic arsenal and increased force readiness required DMA to expand its capabilities to meet growing requirements for weapons systems support. Plans were launched to add to the facilities of the Aerospace Center with a four-story wing, to be equipped with new computer programming and photogrammetric facilities to support the Cruise Missile. To meet these and other requirements, 300 new people were authorized, to bring DMA to an all-time manpower high of nearly 9,000 in Fiscal 1983.

In support of these additional demands upon DMA, a major expansion of the Agency's extensive computer capability also has been undertaken.

Maj. Gen. Richard M. Wells

The development, test and evaluation, and operational deployment, of the MX and TRIDENT II systems will require significant geodetic and geophysical data and products from DMA to meet their respective timetables.

In support of MX, DMA is undertaking in 1982 an extensive land and marine nearshore collection program which, when completed in the fall of 1983, will have measured gravity at 10,000 land and 1,600 marine stations and provided data for DMA development of a launch region gravity model located at the Western Space and Missile Center, Vandenberg Air Force Base, Calif., where the MX will undergo flight testing. When final deployment plans for MX are determined by DoD, DMA will develop gravity requirements for the bases selected.

Requirements to support TRIDENT II include establishment of gravity at 19,000 land and 13,000 marine locations in the southeastern United States and Caribbean area. When these measurements are completed, in late 1983, DMA will provide the Navy with appropriate digital products to support TRIDENT II test and evaluation. Gravity and geophysical data requirements to support operational deployment of TRIDENT II are currently being determined in detail, but first estimates indicate that gravity will have to be measured at more than one million locations in the Atlantic and Pacific regions.

To keep ahead of these and other growing requirements, special programs were established to accelerate development of computerized production techniques at DMA, to best utilize vast amounts of data collected by advanced acquisition systems. This capability is essential if DMA is to meet the expanding MC&G requirements of the next decade.

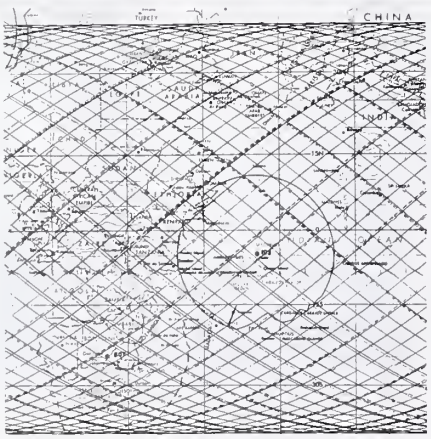
(Right)
Information from many sources provides both terrain and man-made feature data, which is combined into radar return scenes such as this, which guide the Pershing II missile (far right).

Transition into Digitized Products

As the Defense Mapping Agency moved into the 1980s, the transition from conventional to digital mapmaking continued, to the point where more than half of the effort at DMA is now directed towards production of digitized products, as opposed to traditional paper maps and charts.

The Agency is well into the era where its MC&G products are being used directly by the on-board computers of "smart" weapons. Such systems as the Cruise Missile, the FIREFINDER artillery-locating radar, the PERSHING II terminal guidance radar, and a wide range of mission planning simulators and command control systems all depend upon DMA products as an indispensable part of their functions.

Modern day military aircraft are expensive to operate; it's more economical and often more efficient to "fly" these missions under the realistic simulation available today.



DMA charts and data were an integral part of the successful Space Shuttle missions and included projected Earth orbits (left), alternate landing sites and communications stations.

DMA data is used in simulators for the C-130, B-52, F-111, F-16, A-6E and other aircraft, as well as in the Space Shuttle, to train air crews, avoid wear and tear on equipment, and reduce fuel costs—and save lives.

Data used in all these programs, and increasingly in the production of more conventional maps and charts, is constantly being accumulated in massive DMA data bases, which contain worldwide "natural" information (rivers, forests, mountains, etc.) plus "culture" data (man-made bridges, roads, homes, factories, etc.).

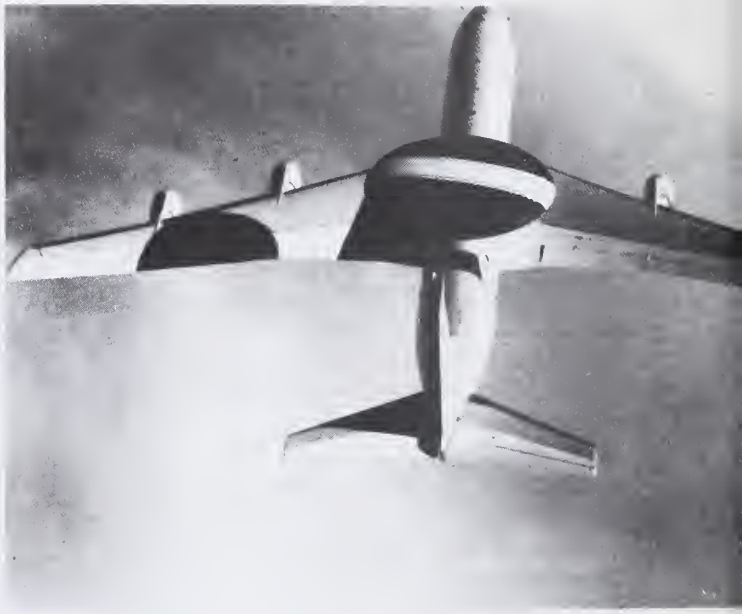
The increasing availability of communications satellites, the advent of fiber optics and the growing capability of processor-to-processor communications permit the rapid transmission of ever-increasing amounts of data. The challenge here to DMA is to structure a system which will permit transmission of its digital data directly to the user.

At the same time, the traditional paper maps and charts will be in use by the Armed Forces for many years to come—in fact, creation of the Rapid Deployment Joint Task Force alone created an increased demand for these products. Increasing use of digitized production techniques will greatly improve the efficiency and accuracy of more traditional printing processes and, in the future, likely lead to direct input of digital information to paper.

Smaller data bases are being developed as needed to support various military systems and, probably within the next decade and a half, they will be joined to form a unified data base. The dramatic strides made in recent years in harnessing computer technology, for use in both the compilation and cartographic functions of mapmaking, will insure that DMA maintains its capability of producing vast amounts of MC&G data in digital form, readily available for retrieval to support a variety of military needs. This information is equally vital in the civil sector, and may be available for use in improved management of Earth resources and enhancement of the environment.

Despite the dramatic advances in this area in the short decade of DMA's existence, most agency professionals agree that fully automated mapmaking is still in its "digital infancy." Major challenges lie ahead, in compilation of information and automated production—as well as in the very area of storage of the massive amount of data acquired in this process.

Soldiers of the 101st Airmobile Division used DMA maps in exercises in the Middle East. The new Rapid Deployment Joint Task Force significantly increased the demand for these traditional products.



Major Users of DMA MC&G Products and Data

	Precise Positions	*Maps/charts*	*Digitized Map (Terrain)*	*Information (Culture)*	*Gravity and Geophysical Data*	*Electronic Navigational Aides*
Aircraft Carriers						
Submarine Systems						
Other surface ships and submarines						
AWACS (Airborne Warning and Control System)						
SAC: B-52, FB-111, KC-135						
TAC: F-15, F-16, A-7, A-10						
MAC: C-130, C-141, C-5A						
Navy/Marine Corps:						
Attack: A-4, A-6, A-7						
Fighter: F-14, F-18						
Patrol: P-3						
Infantry/Mechanized Units						
Tanks						
Attack Helicopters						
Artillery (supported by FIREFINDER System)						
Minuteman, MX						
PERSHING II						
SRAM (Short Range Attack Missile						
Cruise Missiles						
Poseidon/Trident						
U.S. Flag Vessels						
Foreign Flag Vessels						
Private Yachts						

ONE YEAR'S EFFORT

Demands upon the Defense Mapping Agency continue to proliferate -- as new weapons systems are developed and new missions assigned to the nation's Armed Forces.

In Fiscal Year 1981, as production increased over three percent, DMA developed some 700 new maps and charts and updated 2,100, as well as reprinting another 3,400 to keep stockpiles current.

Over 43 million copies of maps and charts were printed, along with some 19 million copies of publications -- navigational booklets and Notices to Mariners and a variety of flight information pamphlets for aviators.

In addition to this traditional production, digital data was developed for more than 5 million square nautical miles on the face of the Earth, much of it for sophisticated weapons systems guidance.

SENIOR DMA OFFICIALS

COMMAND SECTION

Richard M. Wells
Major General, USA
Director

Allen K. Rachel
Brigadier General, USAF
Deputy Director

H. Paul Johnson
Colonel, USA
Chief of Staff

Owen W. Williams
Deputy Director, Management and Technology

Penman Gilliam
Director,
Special Programs
Office for
Exploitation
Modernization

L. Stanard Severance, Jr.
Rear Admiral, USN
Deputy Director, Plan and Requirements

Lawrence F. Ayers
Deputy Director, Programs, Production and Operations

Armando Mancini
Deputy Director, Systems and Techniques

John R. Vaughn
Comptroller

George D. Boale
Director of Personnel

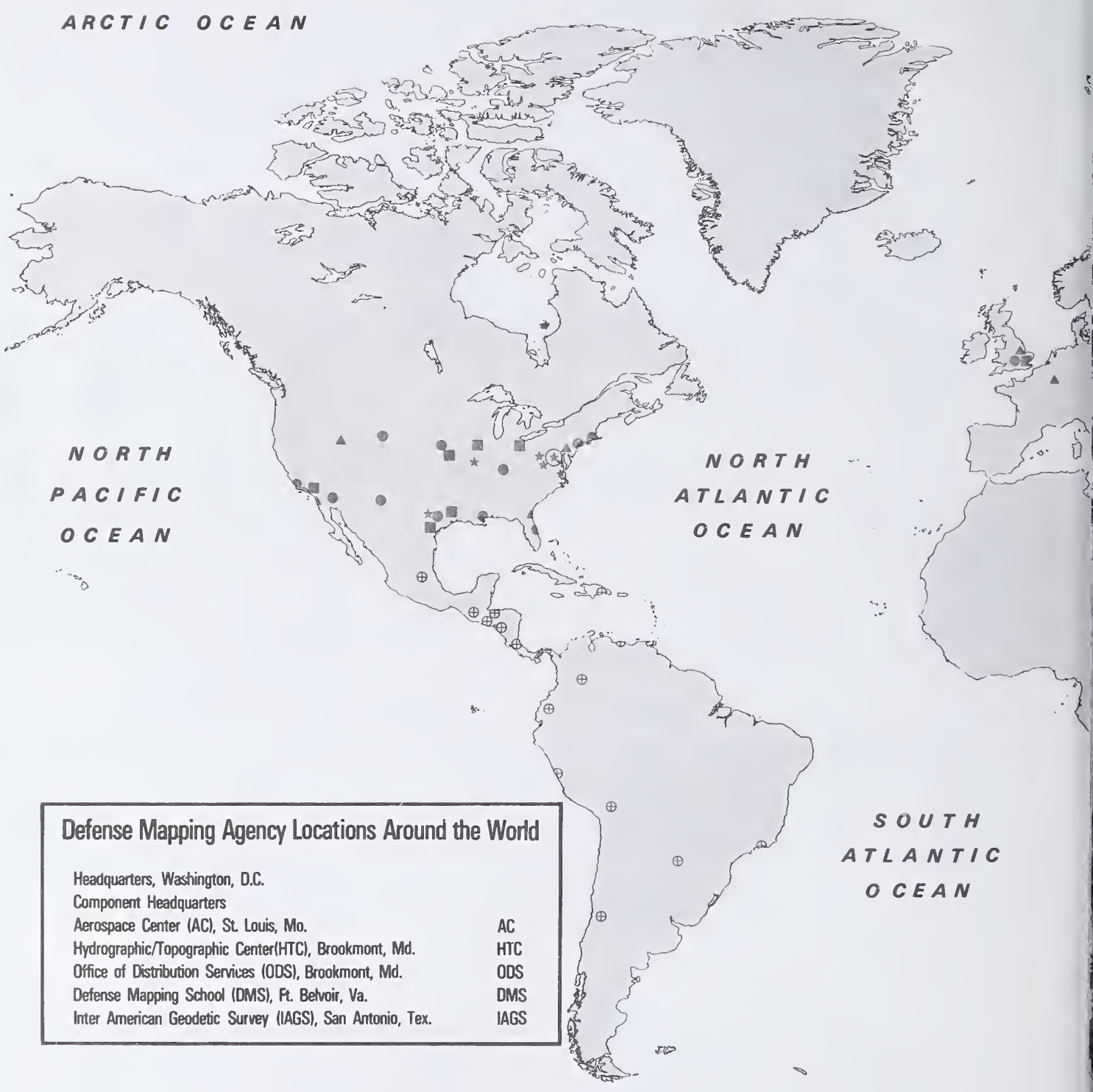
John W. Small
Colonel, USAF
Director, DMA Aerospace Center

Wallace C. Palmer
Captain, USN
Director, DMA Hydrographic/ Topographic Center

Merlin C. Smith, Jr.
Colonel, USAF
Director, DMA Office of Distribution Services

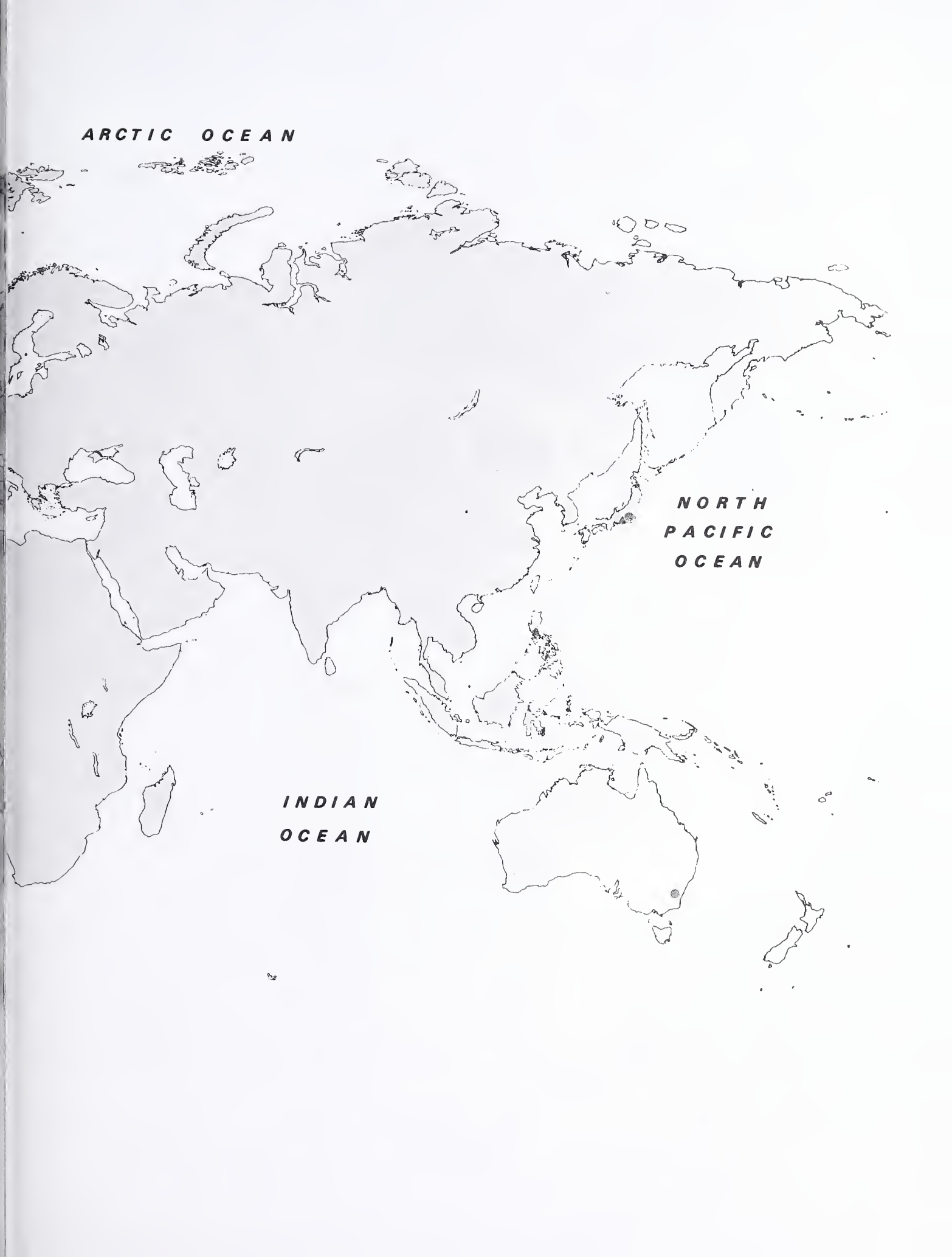
Morton F. Roth
Colonel, USA
Director, DMA Inter American Geodetic Survey

William T. Stockhausen
Colonel, USA
Director, Defense Mapping School



Defense Mapping Agency Locations Around the World

Headquarters, Washington, D.C.	
Component Headquarters	
Aerospace Center (AC), St. Louis, Mo.	AC
Hydrographic/Topographic Center(HTC), Brookmont, Md.	HTC
Office of Distribution Services (ODS), Brookmont, Md.	ODS
Defense Mapping School (DMS), Ft. Belvoir, Va.	DMS
Inter American Geodetic Survey (IAGS), San Antonio, Tex.	IAGS


ARCTIC OCEAN
NORTH PACIFIC OCEAN
INDIAN OCEAN

Mr. Williams

By Owen W. Williams
Deputy Director, Management
and Technology.

While this first decade of DMA's existence has been as dramatic as any in the long history of mapmaking—with truly revolutionary advances in technology—it is clear that we are still on a new frontier.

Since the mid 70s, we have changed our whole philosophy of operations, the standards of our work force, our training and recruiting patterns. In fact, the profession of cartography and its related disciplines literally have undergone a transformation. Far beyond the stereotyped mapmaker at a drawing board with eyeshade and stylus, today's cartographer at the Defense Mapping Agency works with new tools, a dazzling array of computerized equipment capable of producing in the blink of an eye results that traditionally would have taken weeks, or months.

Yet, much of our effort remains manpower intensive. It takes highly skilled professionals to effectively utilize the multi-faceted equipment and emerging techniques now at our disposal. Today's cartographer must acquire a broader base of special skills, a wider range of technical expertise than ever before. And he must be more adaptable, able to assimilate this extensive and continually changing array of information and new tools before him.

Despite these advances, growing and ever more complex demands of the Armed Forces have in the past decade pressed our capabilities to the fullest, requiring seven-day-a-week round the clock effort in some areas to provide the traditional and digitized map products required. Millions of copies of thousands of products, each as unique as a fingerprint, annually flow from our Centers to military "customers" around the world.

Today, while the production level of traditional paper maps and charts has remained almost constant, it is less than half of the overall output from the Defense Mapping Agency; the balance is information in digital form, for guidance of ships, aircraft and the new missiles.

Only by utilizing rapidly the newest and most sophisticated of the new technology have we been able to keep ahead of this demand. We consider it our job in management here to provide these new tools to our people in a timely fashion—whether they need electronic measuring equipment, laser platemakers, digitized cultural data retrieval or whatever.

Our task in the dramatic decade ahead, and beyond, is to keep abreast of, to guide when possible, and to utilize the technological advances that surely are coming. There is no question that the technology will be ready for us to use, in all phases of our work, when we are ready for it. Indeed, management's problem today is to assure that we are ready to accept and utilize this technology as it develops, that it doesn't remain idle, awaiting us.

It would be nice to say that we can see the future clearly. It would certainly save a lot of time, research and expense if we knew just which technological advances were going to occur, in what order. But we do not. So, we must follow the path of the technological evolution that lies ahead. Not a revolution, it will be a "planned evolution" and, while we will have a hand in guiding it, we recognize that we can't entirely predict all the twists and turns that lie along this evolutionary pathway.

We can see three fundamental factors that will influence our future:

1. External Influences:
Of primary importance here is the political/military situation that exists at any given time. This affects the requirements of the Armed Forces to which we respond, and thus the impetus for the resources we obtain and the directions we take both in our production and R&D programs. Related to this is the state of weapon system development, which has had such a significant impact upon our present product mix. The future state of the world, whether at a level of high tension or relative stability, will continue to greatly influence the rate and direction in which the Defense Mapping Agency proceeds.

2. Present Trends in Technology:
Present technology trends provide the basis for the evolutionary process toward all-digital mapping, just as the present state of technology has been achieved through evolutionary processes.

A look at present digital data applications at DMA would illustrate how we have already moved to provide such as elevation and culture data, shorelines and other information in digital form in support of specific weapons and guidance systems, and simulators. The significant point is that our MC&G products are being used directly, computer-to-computer.

In addition, much of our data collection and actual production is directly supported by computerized functions. The names of some of these systems give a hint of the modern technology they embrace: Integrated Photogrammetric Instrument Network (IPIN), Digital Interactive Multi-image Analysis System (DIMIAS), and Image Manipulation System (IMS) are just a few.

While we are now looking at additional computer configurations to make our production capability more efficient, we are proceeding headlong into digital data base technology. We must develop the capability to store, manage and utilize massive volumes of digital data, millions of details from all over the face of the Earth.

Ultimately, mastery of this data base technology will open the door to the future of all-digital production in the MC&G world. Production processes will be revolutionized, with digital data stored in centralized data bases, and available as needed for a variety of applications—in maps, charts, and guidance systems.

3. Influencing Technological Development:
On all sides today it appears that a lot of random technological development is taking place, with DMA latching on to those developments useful in the MC&G area. To some extent this is true, and to be expected given the nature of the commercial marketplace.

However, we are involved enough to influence certain essential developments because we believe we must prepare for the inevitability of all-digital production. Why? First and foremost, it means responsiveness to our customers—the U.S. Armed Forces. We must continue to develop the flexibility to provide these customers the MC&G information they want, when they need it and in the form required. And they are demanding increased responsiveness through greater product flexibility—such as in those weapons systems that use digital data directly into their computers.

Pure economic factors are also involved. For example, in fiscal year 1981 DMA saved about 180 man-years in productive effort through the application of new digital equipment. And part of the answer is that the source collection of the data we need to develop our products is, itself, becoming digital. For example, NASA's Landsat D Satellite, scheduled to be launched in the spring of 1983, will collect Earth resource data which will be available in digital form, capable of being directly programmed through our equipment and recreated as scenes on cathode ray tubes or inserted into our data banks. Other source collection resources are on the way.

Having recognized the advent of the digital era, the Defense Mapping Agency has for a number of years followed a policy of influencing developments where desirable. We are taking advantage of new technology and influencing our evolution by investing in that technology which is required for an all-digital production posture. Since 1975 we have been operating under a planned program leading towards a digital production system, a program referred to as our "System 90s." We envision implementing subsystems throughout the 1980s as they become available after design and testing, with the intent to transfer technology into the production mainstream as soon as it is practicable to do so.

Along with this effort will be the need to maintain a work force that is in step with the new technology. The scope of technological development is mind-boggling, true, but I sincerely believe that the individual in that work force will be the key to how smoothly we move into the era of digital production. Through the 1980s the role of the MC&G professional will expand more than in any time since the 1940s.

The personal and professional challenges that have been met and overcome by the people of the Defense Mapping Agency in its first decade have been but the preliminary for what lies ahead. All of us will be faced with the need to maintain technological currency, and continued self-development will be necessary to keep pace with the state-of-the-art in a score of disciplines.

All this we shall accomplish, in the traditions of those who have gone before us, blazing, and charting, a trail which has brought the military mapmaker to a position where today no military unit, from an infantry squad, to a warship or fighting airplane, to the most advanced strategic or tactical missile—or those in their electronic command posts—may function without the product of that mapmaker's effort.

EMPLOYMENT OPPORTUNITIES

DMA employees perform a staggering variety of tasks encompassing cartography, oceanography, geodesy, geography, mathematics, physics, geology, forestry, electronics, graphic arts, geophysics, engineering and computer sciences. Professional and technical expertise is also needed in many supporting fields, including personnel, financial, purchasing and supply management, building and grounds maintenance, carpentry, plumbing and electrical, to name but a few. Quality people are continually sought to fill these positions.

Persons interested in employment at the Defense Mapping Agency are invited to submit a resume or Civil Service application (SF-171) to any of the offices listed below:

Headquarters
Defense Mapping Agency (POC)
Bldg. 56, U.S. Naval Observatory
Washington, DC 20305

Director
DMA Hydrographic/Topographic Center (POR)
Washington, DC 20315

Director
DMA Hydrographic/Topographic Center
Louisville Office
600 Federal Place
Louisville, KY 40202

Director
DMA Hydrographic/Topographic Center
Providence Office
Brookside Avenue
West Warwick, RI 02893

Director
DMA Hydrographic/Topographic Center
San Antonio Office
Building 4011
Fort Sam Houston, TX 78234

Commander
DMA Hydrographic/Topographic Center
Geodetic Survey Squadron
F.E. Warren AFB, WY 82001

Director
DMA Aerospace Center (POP)
St. Louis Air Force Station
St. Louis, MO 63118

Director
DMA Aerospace Center
Kansas City Office
609 Hardesty Avenue
Kansas City, MO 64124

Director
DMA Office of Distribution Services (PO)
Washington, DC 20315

Director
Defense Mapping School
Fort Belvoir, VA 22060

Director
Inter American Geodetic Survey
Building 144
Fort Sam Houston, TX 78234

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